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REVIEW OF CURRENT TECHNOLOGY IN GLASS FIBRE COMPOSITE

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ABSTRACT

The aim of this work is to study the properties of glass fibre using different types of compositions. In the present paper, we review the current scenario of manufacture and properties of GFRP. In the glass fibre composite, various types of method are used, such as hand lay- up method, resin transfer method (RTM), injection feed method and spatially graded process etc. These method are mostly used to reinforcement the glass fibre composites. It is found that the glass fibre reinforced polymer (GFRP) composite have higher strength as compared to conventional engineer material. One of the limitations in glass fibre is, it has low thermal properties, and therefore, to avoid this problem, we use different types of resin to increase the mechanical property, chemical property and electrical properties. We can increase the strength of our material by increasing or decreasing the weight% composition. Glass fibre and its composite are widely used materials in today's modern world. It is used in a variety of applications such as aircraft, ships, automobiles, sports goods, civil construction, etc.

KEYWORDS: Glass Fibre, Polyester Resin, Epoxy Resin, Mechanical Properties & Electrical Properties

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Original Article

INTRODUCTION

Glass fibre reinforced polymer (GFRP) composites plays an important role in many industries, therefore, the weight is less and strength is more as compare to the metals. Fibre- reinforced polymer composites are one of the most widely used composites materials. The addition of fibre to the polymer matrix increases the mechanical strength of the composite material, as compared to the neat polymer. The fibre reinforced plastic have been frequently used for preparing the structural parts for the automotive parts, marine, civil constructions, electrical, sports goods spacecraft and aircraft. It has high specific stiffness and high specific strength. Glass fibre is not only useful for industrial work, but also in domestic life. It is a relatively cheaper material and easily available compare to materials with similar properties. We briefly study the mechanical and electrical properties of current glass fibre reinforced polymer (GFRP). In this, evaluation of different types of mechanical properties such as tensile, bending, impact strength, hardness and thermal conductivity is also incorporated.

Study on Mechanical Property and Electrical Property of Glass Fibre Composite

Patil Deogonda and others [1] conducted an experimental investigation to find the impact test, three point bending and tensile test on new polymer composite consisting of epoxy resin, glass fibre reinforcement and filler material(ZnS and TiO_2). They used the hand lay-up method to prepare the test piece. From the experimental

analysis, they conclude that from both of the filler materials, the ZnS filled composite perform better than Tio_2 filler composite. Both the filler material made the test piece brittle. Overall, it was observed that the bending, Tensile and Impact strength increased due to the filler material (ZnS and TiO_2)[1].

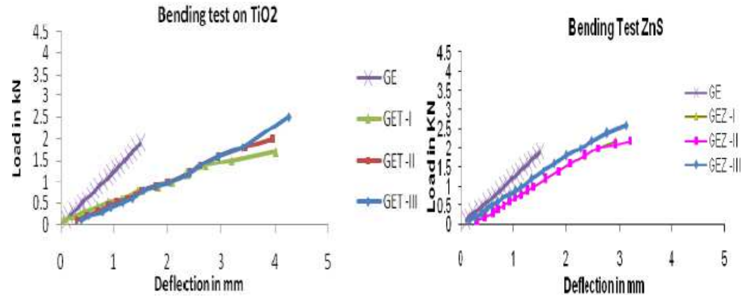


Figure 1: Load –displacement for TiO_2 & ZnS

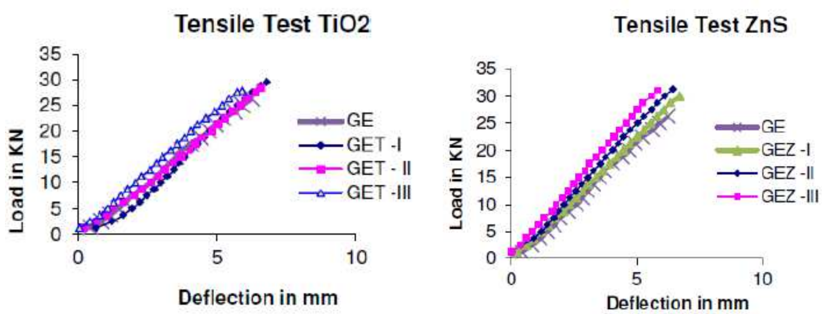


Figure 2: Load- displacement for TiO_2 and ZnS

Cristine M.Becker and others [2] conducted an experimental investigation to find the mechanical & thermal properties of two and three component epoxy composites. The resin transfer moulding (RTM) method was used to synthesize the Layerd doubled hydroxide (LDH) and three component (LDH/epoxy/glass fibre composites). The tensile, impact, flexural, hardness testing and flame test were examined on two and three component epoxy composite. They observed that the performance of mechanical properties was the best, when glass fibre was used as reinforcement and all samples containing LDH composite have lower burning rate.

Abdula Gulla and others [3] anlalysed the tensile strength and impact strength of polypropylene (PP) andpolymide 6 (PA6) plastic. They added the silica coated glass fibre to reinforcement, using injection parameter as the material. They observed that PP and PA6, the added reinforced glass fibre helped to increase mechanical strength. In PP, the tensile strength was at 15 and 30wt% improved by 128 and 198wt%, and in PA6, the tensile strength 74% improved by 111%. The impact energy of PP and PA6 was decreases by 4% and 21%, respectively, when we added 15% fibre, and when we added 30% fibre, the impact energy increased by 14% and 9%, respectively.

Silvio Leonard Valenca and colleagues did the tensile, bending and impact test on Kevlar plain fabric and Kevlar hybrid fabric. They used the hand lay method and scanning electron microscopy. The epoxy resin was used in this method. The bending and impact strength was better in Kevlar hybrid structure. Overall, the Kevlar hybrid structure performed better as compare to Kevlar plain structure.

Rajmohan T and others [5] in their research work evaluated the mechanical properties such as Tensile and compression test of the glass fibre. They used Nano Copper Oxide (CuO) particle to reinforce the fibre and polystyrene resin. In this process, they used the hand lay method and Scanning Electron Microscopy (SEM) for the microscture. They find out that increase in the weight % of Nano particle increased the mechanical strength of glass fibre.

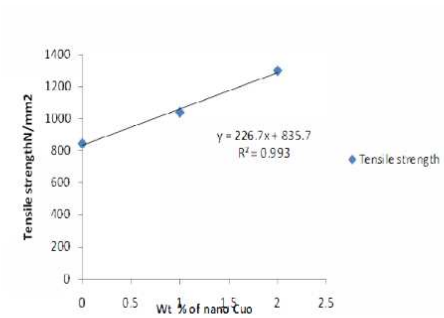


Figure 3: Mathematical Model for Tensile Strength

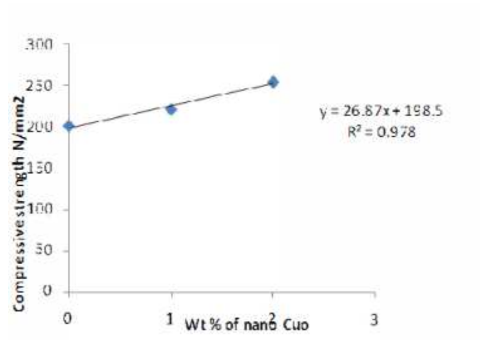


Figure 4: Mathematical Model for Compressive Strength

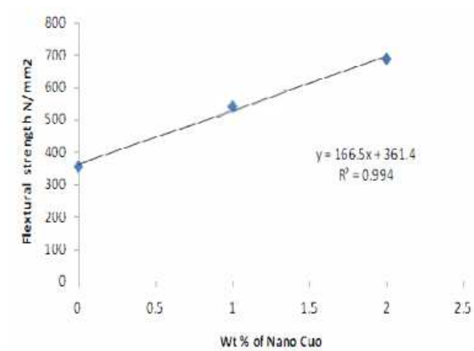


Figure 5: Mathematical Model for Flexural Strength

Nam- Jeong Lee and Jyongsik Jang [6] did the analysis on flexural and impact test of glass fibre polypropylene with spatially graded distribution composites. They used the high fibre and low fibre composites. They observed that, when the load was applied on the high fibre face, it shows the excellent result of flexural strength and impact energy. When the load was applied on face of low fibre composite, it showed poor result of flexural strength and impact energy.

J.M.L. Reis and others [7] did investigation on tensile strength of glass fibre reinforcement polyurethane on various strain rates. They performed quasi static and high strain tensile test of the glass fibre sample. They found that when the modulus of elasticity increases, the strain rate also increased, therefore higher ultimate strength was obtained. They also observed that, it shows the significant result of mechanical test.

Nega Raju B and Ramji K [8] studied the mechanical properties of GFRP-ZnO nanocomposite. They evaluated the results on different compositions of the ZnO on different weight fraction, and also they compared all the different weight fractions results. Their result shows that the ZnO particles shows more effects on mechanical properties. They observed that the tensile strength and hardness is increases, when we add 2wt% of ZnO nanoparticles, and both hardness and tensile strength decreases when we further increase the wt%. When they compared this composition to the different wt% of polymers and glass fibre, the the mechanical properties show improvement in 50/50 wt%.

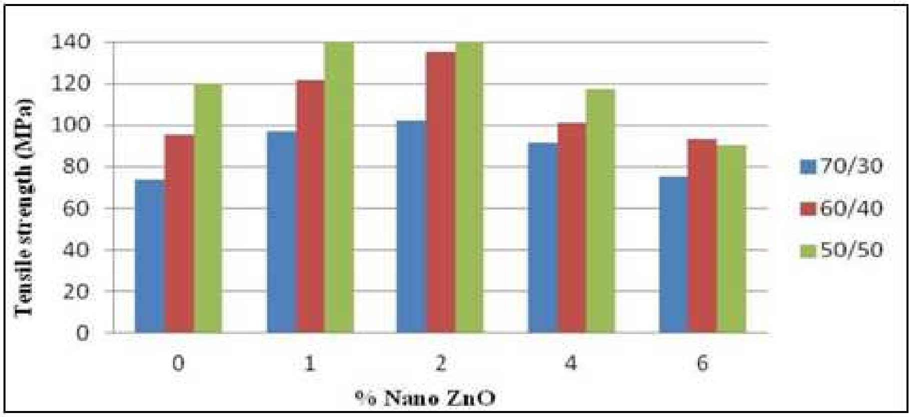


Figure 6: Comparison of Different Wt. Percentages between Tensile Strength and % Nano ZnO and WR as Reinforcement

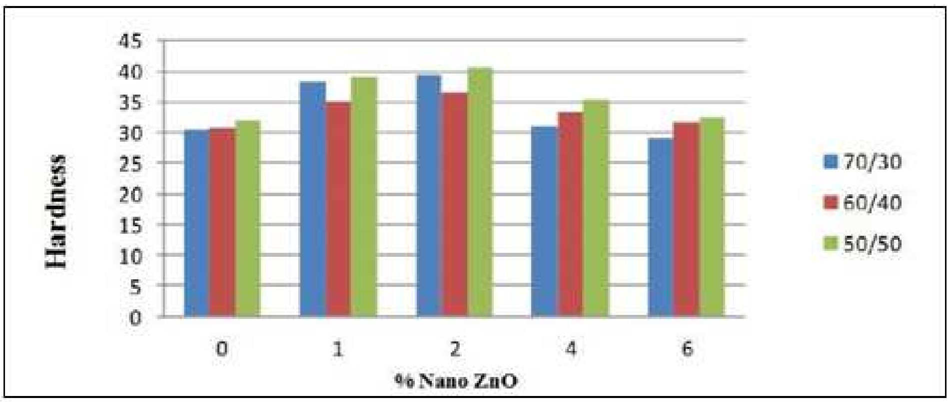


Figure 7: Comparison of different wt. Percentages between Hardness and % Nano ZnO and WR as Reinforcement

Zhang jingya and Sun Rong [9] did experimental investigations on thermal property of glass fibre reinforcement. They used hexagonal boron nitride (h-BN) with different weightage of 20 to 80%. They observed that 60 wt % BN improve the thermal conductivity than 80wt% BN. When we increase weight % of BN by 80%, it decreases the thermal conductivity. BN have the excellent thermal conductivity and thermal stability.

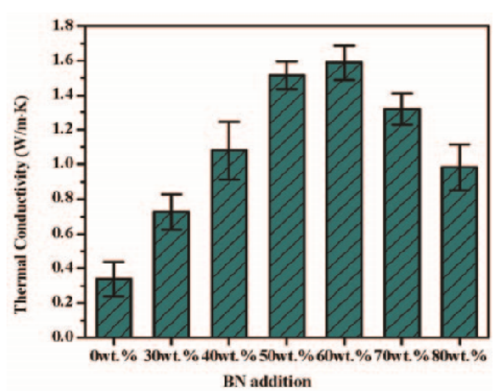


Figure 8: The Thermal Conductivity of GFRBT with Different BN Content

Sudhir S Mathapati and Shivukumar S Mathapati[10]studied on tensile, flexural and compressive strength of E-glass fibre. They used the Bisphenol and various percentage 1%, 2% and 3% of glass fibre. They found that 3% of glass fibre have better result of tensile and bending strength than the other, and 2% show the compression strength and flexural strength decrease, when glass fibre decrease %.

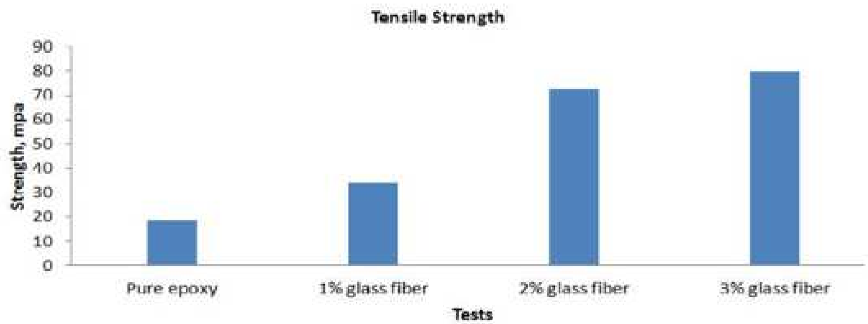


Figure 9:Effect of Glass Fibre Content on Tensile Strength

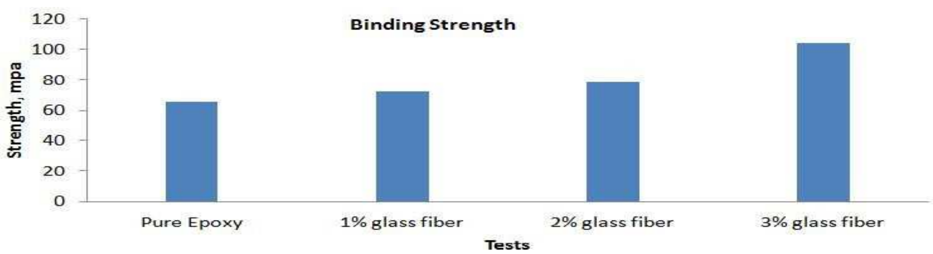
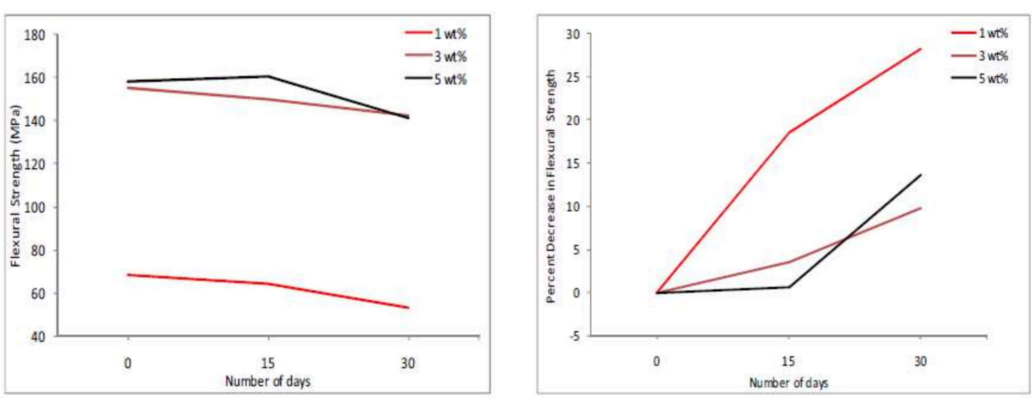


Figure 10: Effect of Glass Fibre Content on Bending Strength.

In the research work by S.K.Singh and S. Singh [11], they described the tensile test, hardness test and flexural test of modified epoxy resin using natural montmorillonate closite 30B (1%, 3%, 5% weight %). The Nano clay was used with E-Glass fibre to manufacture reinforced Nano composite. The hand layup techniques were used in these compositions. They observed that 3% nano clay shows better result of tensile strength and flexural strength, compared to the other. Beyond 3%, Nano clay decreases the hardness strength. All the samples were dipped under water for 30 days, and they observed that 3wt% have less degradation rate, as compared to 1wt% and 5wt%.



(a) (b)

Figure 11(a) Flexural Strength Degradation **Figure 11(b) Percent Decrease in Strength in Water Bath**

P.Pozzi and others [12] studied the re-use of EOL-CRT for preparation of thermoplastic matrix by reinforcement. They examined the fractured surfaces by Scanning electron microscopy. From investigation they observed that the mechanical properties become better by matrix modification in the hybrid composite, and also they concluded that these new fibre have good mechanical and thermal properties, therefore, it can be used instead of commercial glass fibre.

Binu PP and K.E.George [13]studied mechanical and thermal properties of glass fibre filled Cloisite 15 A (0.5, 1, 1.5, 2 weight %) Nano clay composite. They observed that 1% composite show the better result of thermal and impact strength, compared to the other. But, no improvement is shown in the thermal property, and all the samples degraded at 320^{0} c temperature. The fracture strength changes ductility by the addition of Nano clay.

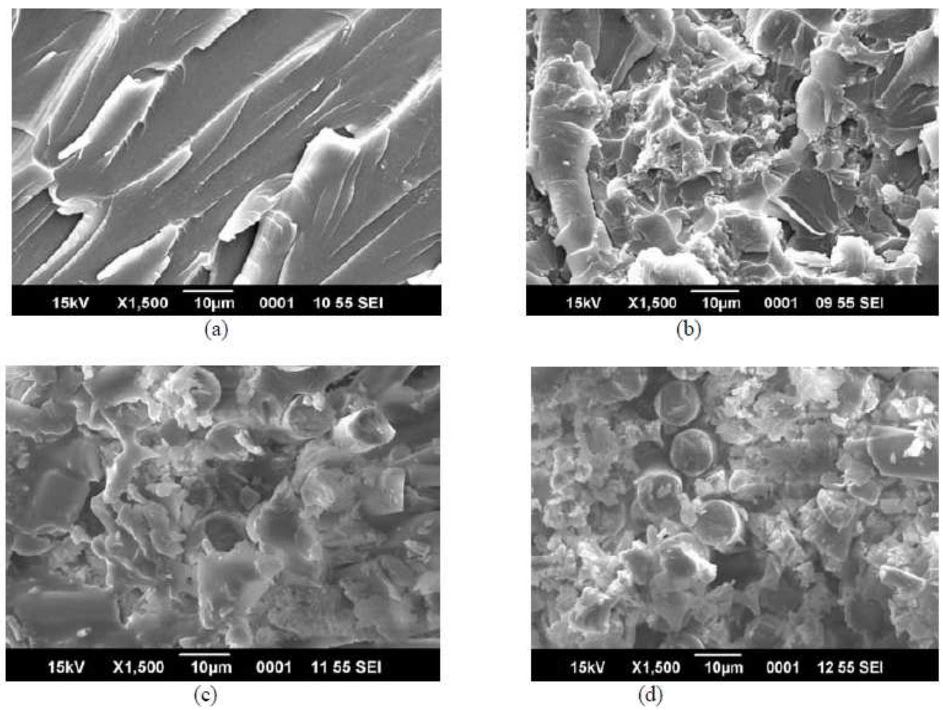


Figure 12: Scanning Electron Microscopy of Fractured Surfaces, (a) Pure Polyester Resin (b) 1% Nanoclay Filledpolyester Resin (c) Pure Polyester Reinforced with Glass Fiber Mat (c) 1% Nanoclay Filled Polyester Reinforced with Glass Fiber Material

R.G.Reid and T.A.I'Ons [14] did the experimental investigation on interlaminar shear test, Izod, impact and tensile test on the Oxyfluorinated hybrid glass fibre and polypropylene fibre. They were used 25% and 50wt% polypropylene. They observe that on increase the percentage of polypropylene after a particular value the mechanical properties decreases. Impact test and tensile test were very low result. But interlaminar shear test found that the excellent result. Overall results were found that it has low mechanical properties.

Suchalinee Maturosemontri and others [15] conducted the experimental study on tensile strength of polyoxymethlyene (POM) composite with glass fibre. They were used the direct feeding fibre injection molding method. They observed that tensile strength was low when the screw rotational speed 172 rpm and 258 rpm. This defect can be improved by increase fibre loading content and increase the cylinder temperature.

K.Nixdorf and G.Busse[16] did the analysis on dielectric property of glass fibre, which used the epoxy resin during polymerisations. They found that the increased fibre % was not having much effect on dipole relaxations and thermal conductivity. The frequency doesn't show any type of effect on the thermal conductivity.

S.Misha and A.K.Mohanty [17] described the tensile, flexural and impact test of bio fibre hybrid composite. They used Pineapple leaf fibre and Sisal fibre with polyester resin. They found that sisal fibre has better result of tensile and impact strength, and the flexural strength increases in hybrid composite. The water absorption of hybrid composite was higher, as compared to the unhybridized composite. Overall, the hybrid composite have better mechanical properties as compare to the unhybridized composite.

G. yuvaraj B and Vijay Ramnath [18] studied the hardness, strength, shear strength and inter de laminations using the sisal hybrid composite. They were using the hand lay method and epoxy resin. They observed that 50-50% compositions of sisal and glass described excellent result. Overall, sisal with epoxy resin improves the mechanical strength of glass fibre.

CONCLUSIONS/ SUMMARY

A Comprehensive review on the investigations of mechanical and electrical properties of glass fibre reinforcement compositions shows very good result.

- The strength increases with wt % of filler material, up to certain level and then decreases. In Nano composite, wt % increases the mechanical strength. Such as $CU_{O,}$ ZN_O and boron nitride wt % also improve the glass fibre strength.
- By comparing the epoxy resin with polyester resin, the epoxy resin has good performance than the polyester resin, because epoxy resin has higher strength, higher durability and more useable than polyester resin.
- The thermal conductivity of glass fibre is low. So, it is used in train toilet and avoids electricity accident.
- The matrix modifications in the hybrid composite enhance the mechanical strength. The waste materials used for composition improve strength. It is called recycle process.
- The fire retardation capacity of glass fibre is high, so, its use in industrial and domestic works. The glass fibre reduces chance of fire accident.
- In direct fibre feeding injections molding process, the tensile property strongly depends upon the feeding rate. When we increase the feeding rate, tensile property decrease and when the feeding rate is less, the tensile property is increasing.
- The Nano clay compositions in glass fibre reinforced polymer decreases the thermal property, but wt % of Nano clay composite increases the mechanical properties
- The glass fibre has higher strength. So, it is useful for heavy work such as automobile body, bumper and aerospace wings, engine ducts etc.

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